Methanol Synthesis Using Microchannel Reactors for Off-Shore Applications

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Summary:

Methanol synthesis has been studied at a temperature of 255 ^{o}C and pressure of 80 bara. The studies have been carried out in microchannel reactor made of stainless steel. The rates and selectivities have been compared with corresponding results obtained in a fixed bed reactor.

Keywords: microchannel reactor, methanol synthesis, off-shore, heat transfer, fixed bed reactor, comparative study

Extended Abstract:

The proven natural gas reserves in the world exceeds 6000 Trillion Cubic Feet (TCF), from which about 50% is located in remote areas with no economic feasibility to be produced, shipped and sold. Approximately half of the stranded gas reserves are located off-shore. This implies the necessity to find solutions for utilization of most of the undiscovered natural gas reserves, including the Norwegian continental shelf as well as the arctic area, considering the growing demand in fuel and chemicals market.

Among different ways for remote off-shore natural gas monetization, on-site conversion into readily transportable fuels such as diesel, naphtha, methanol or DME is of great interest for energy companies. Limitations in space and weight, as well as demanding site-conditions, call for highly integrated, compact, low weight and safe technology. Microreaction technology features unique advantages in terms of heat and mass transfer and could be a reasonable choice for the methanol or the Fischer-Tropsch syntheses, for which highly exothermic and complex reaction systems are linked to the selectivity and reactor performance.

The present research specifically addresses an experimental study of methanol synthesis from synthesis gas in a microchannel reactor-heat exchanger made by Forschungszentrum Karlsruhe (FZK). The reactor is made from stainless steel. The reaction is highly exothermic and limited by thermodynamic equilibrium. The heat is removed by cross flow heat transfer oil channels. A conventional fixed bed reactor with identical operating conditions is used to

compare the reaction performance and transport phenomena between the two systems. The products are analyzed by gas chromatography.

A powdered commercial CuO/ZnO catalyst is used to study the reactivity in the microchannel reactor as well as in the fixed bed reactor. The reaction is studied at a temperature of 255 ^{o}C and pressure of 80 bara, and the performance (single pass CO conversion and the methanol productivity) of both reactors is investigated at different contact times. Different pressures and temperatures are also included in the study. At the mentioned operational conditions, deactivation studies are also performed in order to investigate the rate of catalyst deactivation in both reactors in a comparative way. The detailed description of these studies will be presented and discussed in the lecture presentation.